REMARKS:

Claims 1, 2, 6-8, and 22-30 are pending. Claims 4, 5, 9-21 have been cancelled. Claims 1, 6, and 7 have been amended. Support for amended claim 1 is found, *inter alia*, in originally filed claim 4 and in the specification on page 3, lines 10-16. Claim 6 has been amended to remove a claim limitation added to twice amended claim 1. Claim 7 has been amended merely to change dependency from claim 6 to claim 1. New claims 22-30 have been added. Support for new claim 22 is found, *inter alia*, in originally filed claims 1 and 5. Support for new claims 23 and 28 is found, *inter alia*, in originally filed claim 2. Support for new claims 24 and 29 is found, *inter alia*, in originally filed claim 6. Support for new claims 25 and 30 is found, *inter alia*, in originally filed claim 7. Support for new claim 26 is found, *inter alia*, in originally filed claim 8. Support for new claim 27 is found, *inter alia*, in originally filed claims 1 and 8. Applicants have amended the Summary Of The Invention section so that it reflects amended claim 1 and new independent claims 22 and 27. Also, applicants have amended the Abstract section so that it reflects amended claim 1.

No new matter has been added. As documented herein, the amendment to claim 1 and the addition of new claims 22-30 merely incorporate the wording of already pending claims, and thus, the amendment to claim 1 and the addition of new claims 22-30 do not raise any new issues requiring further search by the Examiner. Furthermore, the number of claims has not been increased. Applicant respectfully requests that the amendments, as documented herein, be entered by the Examiner, and the application be reexamined and reconsidered.

On page 2 of the Office Action, the Examiner states: "Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits. Accordingly, claims 9 and 13-18 are withdrawn from consideration as

being directed to a non-elected invention." Applicants have cancelled withdrawn claims 9 and 13-18 without prejudice.

Also, on page 2 of the Office Action, the Examiner states: "The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed." Applicants have amended the title of the invention to be clearly indicative of the invention to which the claims are directed.

On page 3 of the Office Action, the Examiner states:

> The amendment filed June 26, 2002 is objected to under 35 U.S.C. 132 because it introduces new matter into the disclosure . . . . The added material which is not supported by the original disclosure is as follows: "without using plasma", "preferably every time a thickness of the formed silicon nitride film reaches 3000 angstroms, the silicon nitride film formed in the reaction chamber is removed, with NF_3 gas flowing into the reaction container".

Applicants have amended claim 1, amended the Summary Of The Invention section, amended the Abstract section of the specification, and cancelled claim 19 to remove the wording "without using plasma." However, applicants traverse the Examiner's objection to the disclosure of the invention regarding the wording, "preferably every time a thickness of the formed silicon nitride film reaches 3000 angstroms, the silicon nitride film formed in the reaction chamber is removed, with NF3 gas flowing into the reaction container," support for which is readily found in the specification on page 12, lines 5-10, and page 14, lines 13-16. Accordingly, withdrawal of these grounds for objection are respectfully requested.

Also, on page 3 of the Office Action, the Examiner rejects claims 1, 2, 4-8, 10-12, and 19-21 under 35 U.S.C. 112, first paragraph. Specifically, the Examiner states that the rejected claims 1, 2, 4-8, 10-12, and 19-21 are rejected,

> as containing subject matter which was not discussed in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The new limitations: "without using plasma", "every time a thickness of the formed silicon nitride film reaches 3000 angstroms, the silicon nitride film formed in

the reaction container is removed, with NF3 gas flowing into the reaction container".

Applicants have cancelled claims 4, 5, and 10-12, and 19-21, and thus, the rejections to those claims are moot. Also, applicants have amended claim 1 to remove the wording "without using plasma." Accordingly, applicants submit that amended independent claim 1 and depending claims 2, and 6-8 comply fully with 35 U.S.C. § 112, first paragraph, and the rejection based thereon should be withdrawn.

Applicants traverse the Examiner's rejection to the wording, "every time a thickness of the formed silicon nitride film reaches 3000 angstroms, the silicon nitride film formed in the reaction chamber is removed, with NF3 gas flowing into the reaction container," support for which readily found in the specification on page 12, lines 5-10, and page 14, lines 13-16.

On page 4 of the Office Action, the Examiner rejects claims 1, 2, and 4-8 under 35 U.S.C. § 103(a) as being unpatentable over Mori et al. (JP 06-080962) in view of Moore et al. (USP 6,251,802). In addition, on page 5 of the Office Action, the Examiner rejects claim 1 under 35 U.S.C. § 103(a) as being unpatentable over Langan et al. (USP 5,413,670) in view of Moore. A prima facie obviousness rejection requires that the prior art reference, or references, when combined, must teach all of the claim limitations. MPEP § 2143.03; In re Fine, 837 F.2d 1071, 5 U.S. P.Q.2d (BNA) 1596 (Fed. Cir. 1988). Applicants have cancelled claims 4 and 5, and thus, the rejections to claims 4 and 5 are moot. Applicants respectfully traverse these rejections to claims 1, 2, and 6-8.

Claim 1 recites a semiconductor device manufacturing method including a first step of forming, by a thermal chemical vapor deposition method, a silicon nitride film on an object disposed in a reaction container, with bis tertiary butyl amino silane and NH_3 flowing into the reaction container, and a second step of removing silicon nitride formed in the reaction container, with NF_3 gas flowing into the reaction container, before the silicon nitride film formed in the reaction container reaches a thickness of 4,000 Å.

Claim 22 recites a semiconductor device manufacturing method including a first step of forming, by a thermal chemical vapor deposition method, a silicon nitride film on an object disposed in a reaction container, with bis tertiary butyl amino silane and NH_3 flowing into the reaction container, and a second step of removing silicon nitride formed in the reaction container, with NF_3 gas flowing into the reaction container, before the silicon nitride film formed in the reaction container reaches a thickness that generates particles on the object.

Claim 27 recites a semiconductor device manufacturing method including a first step of forming, by a thermal chemical vapor deposition method, a silicon nitride film on an object disposed in a reaction container, with bis tertiary butyl amino silane and NH_3 flowing into the reaction container, a second step of removing silicon nitride formed in the reaction container, with NF_3 gas flowing into the reaction container, and a step of purging the reaction container using the NH_3 gas at least one of before and after the first step.

Applicant submits that amended independent claim 1 and new independent claims 22 and 27 are patentable over Mori in combination with Moore and Langan in combination with Moore because neither Mori, Langan, nor Moore teach or suggest, "removing silicon nitride formed in said reaction container, with NF_3 gas flowing into said reaction container, before said silicon nitride film formed in said reaction container reaches a thickness of 4,000 Å," as required by claim 1, or, "removing silicon nitride formed in said reaction container, with NF_3 gas flowing into said reaction container, before said silicon nitride film formed in said reaction container reaches a thickness that generates particles on said object," as required by claim 22, or, "a step of purging said reaction container using said NH_3 gas at least one of before and after said first step," as required by claim 27.

The Examiner, on page 4 of the Office Action, cites Mori for teaching, "forming a silicon nitride film on a reaction container, removing silicon nitride film by introducing NF_3 gas . . . the silicon nitride film is deposited by CVD using silane and NH_3 . . . the pressure ranging from several Torr to normal pressure . . . ." On

page 5 of the Office Action, the Examiner cites Langan for teaching, "forming a silicon nitride film on a reaction container, removing silicon nitride film from a CVD reactor by introducing NF_3 gas . . . ." On pages 4 and 5 of the Office Action, the Examiner merely cites Moore for teaching, "the use of bis tertiary butyl amino silane."

However, neither Mori, Langan, nor Moore teach or suggest, "removing silicon nitride formed in said reaction container, with NF_3 gas flowing into said reaction container, before said silicon nitride film formed in said reaction container reaches a thickness of 4,000 Å," "removing silicon nitride formed in said reaction container, with NF_3 gas flowing into said reaction container, before said silicon nitride film formed in said reaction container reaches a thickness that generates particles on said object," or, "a step of purging said reaction container using said NH_3 gas at least one of before and after said first step."

As described on page 2, line 11 to page 3, line 9 of the specification of the present application, the silicon nitride film according to the present invention formed using bis tertiary butyl amino silane (BTBAS) and NH_3 has a stronger film stress and a greater film shrinkage than the silicon nitride film formed by plasma CVD method using SiH_4 and NH_3 (or SiH_2Cl_2 and NH_3) disclosed in Mori et al., and therefore, these two films are different from each other in a critical film thickness at which a microcrack is generated and thus particles are generated on the wafer. The present inventors have found that t he critical thickness of the silicon nitride film formed using (BTBAS) and NH_3 which may cause the microcrack is 4,000 Å, and new claim 1 is based upon these findings, which are not disclosed nor suggested in any of the references cited.

Accordingly, applicants submit neither Mori, Langan, nor Moore, nor any combination of Mori, Langan, and Moore, teach or suggest all of the requirements of amended independent claim 1 or new independent claims 22 and 27. Therefore, amended independent claim 1, new independent claims 22 and 27, and their depending claims 2, 6-8, 23-26, and 28-30, are patentable over the cited references.

In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Reexamination and reconsideration of the application, as amended, are requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (213) 337-6700 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,
HOGAN & HARTSON L.L.P.

Date: April 21, 2003

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Version with markings to show changes made:

In the title:

SEMICONDUCTOR DEVICE MANUFACTURING METHOD AND APPARATUS FOR REMOVING SILICON NITRIDE FORMED IN A REACTION CONTAINER WITH NF_3 GAS FLOWING INTO THE REACTION CONTAINER

In the specification:

Page 4, line 13, through page 6, line 13:

a second step of removing[, without using plasma,] silicon nitride formed in the reaction container, with NF_3 gas flowing into the reaction container, before said silicon nitride film formed in said reaction container reaches a thickness of 4,000 Å.

Preferably, the semiconductor device manufacturing method according to the first aspect of the present invention further comprises the first step after the second step. That is the semiconductor device manufacturing method according to the first aspect of the present invention preferably comprises the first step, thereafter the second step and thereafter the first step again.

[Preferably, before the silicon nitride film formed in the reaction container reaches a thickness of 4000 Å, the silicon nitride formed in the reaction container is removed, with NF_3 gas flowing into the reaction container.

Preferably, before the silicon nitride film formed in the reaction container reaches a thickness that generates particles on the object, the silicon nitride formed in the reaction container is removed, with NF_3 gas flowing into the reaction container.

]Preferably, the reaction container is made of quartz and/or a member made of quartz is used in the reaction container[, and before the silicon nitride film formed on the quartz is increased to a thickness that generates particles on the object, the NF_3 gas is allowed to flow into the reaction container to remove the

silicon nitride formed on the quartz. In this case, it is preferable to remove the silicon nitride with NF_3 gas before the thickness of the silicon nitride becomes 4000 Å or larger].

Preferably, the second step is carried out in a state where a pressure in the reaction container is greater than or equal to 10 Torr.

[Preferably, the semiconductor device manufacturing method according to the first aspect of the present invention further comprises a step of purging the reaction container using the NH_3 gas at least one of before and after the first step.

Preferably, every time a thickness of the formed silicon nitride film reaches 3000 Å, the silicon nitride film formed in the reaction container is removed, with NF_3 gas flowing into the reaction container.]

According to a second aspect of the present invention there is provided a semiconductor device manufacturing [apparatus including:

a reaction container;

a heater provided outside of the reaction container;

an object mounting device to be disposed in the reaction container;

a first gas charging port for charging bis tertiary butyl amino silane into the reaction container; and

a second gas charging port for selectively charging one of NH_3 and NF_3, thereby performing one of

forming a silicon nitride film, by a thermal chemical vapor deposition method, on an object disposed in the reaction container, with bis tertiary butyl amino silane and NH_3 flowing into the reaction container, and

removing silicon nitride formed in the reaction container, with NF_3 gas flowing into the reaction container.

According to third aspect of the present invention there is provided a reaction container cleaning method including:

flowing NF_3 gas into the reaction container; and

removing, without using plasma, a silicon nitride film formed in the reaction container.]method including:

a first step of forming, by a thermal chemical vapor deposition method, a silicon nitride film on an object disposed in a reaction container, with bis tertiary butyl amino silane and NH_3 flowing into the reaction container, and

a second step of removing silicon nitride formed in the reaction container, with NF_3 gas flowing into the reaction container, before the silicon nitride film formed in the reaction container reaches a thickness that generates particles on the object.

According to a fourth aspect of the present invention there is provided a semiconductor device manufacturing method including:

a first step of forming, by a thermal chemical vapor deposition method, a silicon nitride film on an object disposed in a reaction container, with bis tertiary butyl amino silane and NH_3 flowing into the reaction container; and

a second step of removing silicon nitride formed in the reaction container, with NF_3 gas flowing into the reaction container; and

a step of purging the reaction container using the NH_3 gas at least one of before and after the first step.

Page 20, lines 1-9:

ABSTRACT

A reaction container cleaning method includes flowing NF_3 gas into the reaction container, and removing[, without using plasma,] a silicon nitride film formed in the reaction container.

IN THE CLAIMS:

1. (Twice Amended) A semiconductor device manufacturing method comprising:

a first step of forming, by a thermal chemical vapor deposition method, a silicon nitride film on an object disposed in a reaction container, with bis tertiary butyl amino silane and NH_3 flowing into said reaction container, and

a second step of removing[, without using plasma,] silicon nitride formed in said reaction container, with NF_3 gas flowing into said reaction container, before said silicon nitride film formed in said reaction container reaches a thickness of 4,000 Å.

6. (Twice Amended) The semiconductor device manufacturing method as recited in claim 1, wherein

said reaction container is made of quartz and a member made of quartz is used in said reaction container[, and

before said silicon nitride film formed on said quartz is increased to a thickness that generates particles on said object, said NF_3 gas is allowed to flow into said reaction container to remove said silicon nitride formed on said quartz].

7. (Twice Amended) The semiconductor device manufacturing method as recited in claim [6]1, wherein

said second step is carried out in a state where a pressure in said reaction container is greater than or equal to 10 Torr.